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The Decline of Illegitimacy and the Control of Marital Fertility During the Demographic Transition. Testing the Innovation-diffusion Hypothesis Using Cohort Fertility Data from a Belgian Town, 1850-1910

*Jan Van Bavel**

Abstract: One of the major arguments made in the literature in support of the view that the European fertility transition was the result of the spread of an innovation called contraception, is that illegitimate fertility fell together with marital fertility. Indeed, the parallel decline of both illegitimacy and marital fertility in the final part of the nineteenth century suggests that individuals in Europe were applying new forms of contraceptive behaviour that were previously not done or even unthinkable. The aim of this contribution is to investigate one implication of the argument: if the diffusion hypothesis is correct, one would expect that women who got children before marriage would be less likely to control their fertility by means of parity-dependent stopping behaviour within marriage than comparable women without premarital births. This hypothesis is investigated with a logistic regression model of stopping behaviour using data from three birth cohorts living in the Belgian town of Leuven between 1850 and 1910. The results indicate that, at least in Leuven, the decline of illegitimacy can at most only partly be explained by the diffusion of innovative contraceptive behaviour. More than backing up the diffusionist interpretation, the findings lend particular support to the courtship model of premarital pregnancies and births. The

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findings also suggest that, during the initial stage of the fertility transition, non-marital childbearing may have reflected a liberal attitude towards reproduction for some. In turn, this liberal attitude in a “bastardy-prone subsociety” may also have been positively associated with early stopping behaviour.

One of the major arguments made in the literature in support of the view that the European fertility transition was the result of the spread of an innovation called contraception, is that illegitimate fertility fell together with marital fertility. For example: “The single most telling piece of evidence to support the view that pregnancy prevention was indeed an innovation is the fact that illegitimate fertility fell in parallel with marital fertility” (Cleland 2001: 48). This parallelism was discussed in 1971 by Shorter, Knodel, and van de Walle (1971): “It is a salient and little known fact that in most parts of Europe non-marital fertility duplicated the widely known decline in marital fertility” (p.375). More frequently cited – probably one of the most often cited references in the literature about the fertility transition in Europe – is the “Lessons from the past” paper by Knodel and van de Walle (1986). Noting the simultaneity of both marital and non-marital fertility decline, the authors argue that the more plausible interpretation is

that birth control practices were not widely diffused prior to the parallel declines in legitimate and illegitimate fertility and that the spread of the knowledge and skills to avoid unwanted births enabled both married and unmarried couples to reduce their fertility simultaneously (p.403).

The parallel decline of both illegitimacy and marital fertility indeed does suggest that individuals in Europe were applying new forms of contraceptive behaviour that were previously very uncommon. Yet, as pointed out already by Schellekens (1995), this interpretation of the decline of illegitimate fertility has not been put to serious test. To date, this still has hardly been done while there is at least one reason why the diffusionist interpretation should be questioned. If we agree, in line with Shorter et al. (1971) and with Knodel and van de Walle (1986), that a higher proportion of births out of wedlock was unwanted than among births within marriage, then we would expect that the decline of non-marital fertility would be sharper than the decline of marital fertility, as a consequence of the diffusion of birth control skills. This was not the case.

The main objective of this contribution is to investigate one implication of diffusionist interpretation of the decline of illegitimate fertility: if that interpretation is correct, one would expect that women who got children before marriage would be less likely to apply newly introduced forms of contraceptive behaviour within marriage than comparable women without births before marriage. The hypothesis is investigated using data from three birth cohorts living in a Belgian town between 1850 and 1910.

Nonmarital fertility, nuptiality, and marital fertility

In his seminal article, Phillips Cutright (1971) used the framework of the proximate determinants of fertility to derive ten steps to unmarried motherhood, as recorded in official vital statistics: a woman (1) who is not yet married (2) should have sexual intercourse (3) while being fecund and (4) without applying effective contraception. Then, (5) sexual intercourse should lead to a pregnancy that (6) does not end with a spontaneous abortion nor (7) with an induced abortion. If the woman (8) does not marry before childbirth and (9) if the child is not stillborn, then she becomes an unwed mother. The birth (10) may or may not be registered by the authorities as illegitimate.

Shorter and his colleagues (1971) ruled out four of these nine steps as candidates to play a role in the decline of illegitimate fertility at the end of the nineteenth century: the prevalence of sterility (step no. 3), fecundability (i.e. the monthly probability of conception for sexually active, non-contraceptive and non-sterile women, step no. 5), non-induced intra-uterine mortality (steps no. 6 and 9), and underreporting in vital statistics (step no. 10). The historical evolution of these four determinants of recorded illegitimate fertility would, if anything, imply a rise rather than a drop of illegitimacy.

An additional issue, related to step no. 1, concerns the definition of marriage employed by the civil registrars: some people may regard themselves as legitimately married and nevertheless be refused this marital status by officials. A marriage certified by a religious denomination but not sanctioned by the civil authority is a typical case in point. However, during the time period at issue here, i.e. the first episode of the fertility transition, civil marriage was already well established and no change occurred in the definition of marriage in most North-Western European countries (Segalen 1993: 115-131). Hence, we can assume that the changing definition of marriage cannot explain the decline of illegitimacy during the latter part of the nineteenth century.

So, only four of Cutright's ten steps to unwed motherhood remain candidates that were potentially involved in the decline of illegitimate fertility: the extent of non-marital sexual activity, contraceptive behaviour, induced abortion, and the likelihood of a marriage before childbirth (but not necessarily before conception). The diffusionist interpretation of the decline of illegitimacy implies that contraception has played a major role, possibly in combination with abortion.

Schellekens (1995) published an explicit empirical test of the diffusionist hypothesis in an analysis of the decline of illegitimate fertility in England between 1851 and 1911. The English data were not at odds with the idea that some of the decline can be explained by the extent to which contraceptive methods were used. However, the explanatory power of the use of contraception – as far as indirectly measured by the level of marital fertility – decreased substantially in the English case once a measure of nuptiality was included in

the regression analysis. Schellekens therefore concluded that “a change in the knowledge and acceptability of contraception does not seem to be a major explanation at the early stages of the decline” (p.374).

The proximate determinants approach should make clear that alternative explanations are not incompatible with the diffusionist perspective. A major alternative view is the courtship model (Laslett 1980a). The essence of this model is that marriage and illegitimacy are two different outcomes of courtship behaviour (Alter 1988: 116-125). In a nutshell: from a courting woman’s point of view,

the risk of becoming an unwed mother had to be weighed against the risk of remaining a spinster. If she were to agree to her partner’s demand for sexual intimacy, she could perhaps strengthen their relationship and increase the likelihood that they would marry. On the other hand, she risked conceiving a child and becoming an unwed mother (Alter 1988: 120).

Clearly, this model sees ups and downs in unwed motherhood as a function of the extent of non-marital sexual activity and the likelihood of marriage in case of pregnancy (i.e. steps (2) and (8) in the Cutright 1971 framework, described above).

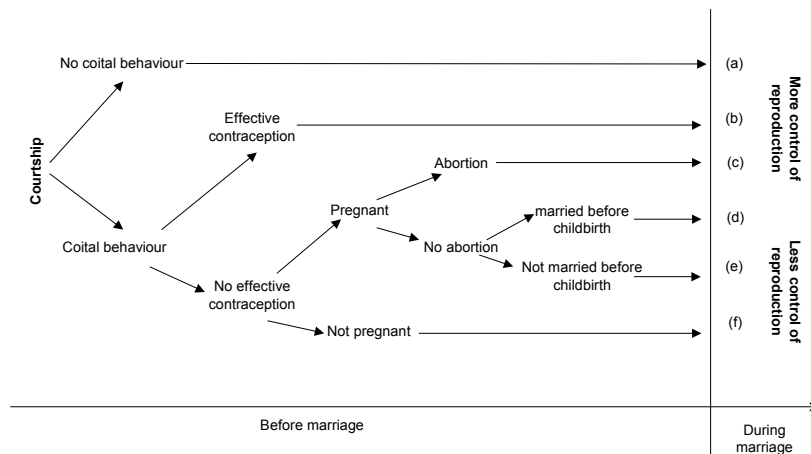
The courtship view on illegitimacy was highly inspired by the finding by Peter Laslett et al. (1980: ix) that age at marriage and illegitimacy were inversely related. Contrary to the expectations, illegitimacy went up as age at marriage went down, and vice versa (Laslett 1980a: 20-24). Yet, this surprising relationship did not hold everywhere (see, for example, Knodel 1988: 227-229; Kok 1990; 1991), and even in England the observation holds only until the middle of the nineteenth century. After that, both illegitimate fertility and age at marriage were on the decline in most European countries until the 1960’s (Coale & Treadway 1986; Watkins 1986). As noted by Cutright (1971) and Shorter et al. (1971), this decline coincided with the decline of marital fertility.

Clearly, Laslett’s courtship model has no universal applicability and needs qualification. As said, Laslett’s view was highly inspired by the observation that age at marriage and illegitimacy were inversely related. The explanation given for this inverse relationship was that courtship activity is likely to increase as the circumstances become more and more appropriate for marriage, in principle. If there is more early courtship behaviour, there will not only be more early marriages but also more women who are running the risk of becoming unwed mothers. Hence, the number of births out of wedlock rises (Laslett 1980a: 53-65). Yet, an increase in early courtship behaviour may also result in a decrease of illegitimacy if a higher proportion of early courtships end with marriage before childbirth rather than with the birth of an illegitimate child. This increase in the proportion of courtships resulting in marriage rather than illegitimacy may be the result of improved marriage opportunities, possibly created by better economic conditions (Tilly, Scott & Cohen 1976; Schellekens 1995).

To sum up: in the courtship model, early courtship behaviour may result in more as well as in less illegitimacy, depending on the likelihood of marriage before a child is born to an unmarried couple. By itself, courtship behaviour touches upon the proximate determinant identified above as (2), i.e. the extent of non-marital sexual activity. The outcome of this behaviour depends on the other proximate determinants, i.e. on contraception, abortion, and the likelihood of marriage.

The rest of the paper investigates the plausibility of the hypothesis that the diffusion of contraceptive or abortive behaviour has played a major role in the decline of illegitimacy. This is done by testing hypotheses about the relationship between premarital courtship outcomes and subsequent fertility control within marriage. Figure 1 may help to explain the logic of the argument, which is as follows.

Fig. 1: The outcome of premarital courtship behaviour and control of reproduction during marriage



Some couples have coital experience before marriage, some haven't. To some extent, courtship without coital experience may be a sign of a high amount of self-control; couples who have no sex before marriage (group (a) in Figure 1) may exhibit a "culture of abstinence". This culture is instrumental in having control over reproduction (Szreter 1996), both before and during marriage. Control may be exerted for family limitation, but given the appropriate motivation, control may just as well be employed to achieve a large family. A "culture of abstinence" combined with a motivation to have a large family has

often been characteristic of conservative religious groups, typically exhibiting high marital fertility (McQuillan 1999). People belonging to this category (group (a) in Figure 1) will have neither illegitimate births nor pre-nuptial pregnancies.

With our historical data, we cannot distinguish between group (a) in Figure 1 and groups (b) and (c). Group (b) consists of couples who did have sex before marriage, but who were able to avoid any premarital conceptions by employing effective contraceptive techniques, while (c) are the couples with coital experience who did not employ any effective contraception but who avoided illegitimacy by means of abortion. Finally, with our data it is also not possible to tell (a), (b), or (c) from group (f). The latter includes women who could have run the risk of conceiving a child before marriage by having sex without contraception, but who (by chance) did not get pregnant. What our data do allow, is to distinguish all groups discussed so far from groups (d) and (e). Characteristic of these two groups is that they manifest a lack of contraceptive or abortive behaviour before marriage. If contraception or abortion, or both, did play a role in avoiding conceptions out of wedlock, then one should expect that women and/or couples who are knowledgeable about effective contraceptive or abortive practices are *under*-represented among those who gave birth to a child conceived out of wedlock. Conversely, those who know about contraception or abortion are expected to be *over*-represented among those who first got married before conceiving a child. Therefore, if the diffusion of contraception and abortion was important in bringing down illegitimacy in Europe after 1850, we would expect that groups (d) and (e) manifest less sexual and reproductive control during their marriages as well.

In his study of fertility of nineteenth century poor people in the Belgian town of Huy, Oris (1988: 152-153) observed a relationship between illegitimacy and marital fertility that supports the argument made here. He noted that needy couples with premarital births, who had by this very fact proved to have had sex before marriage, were less affected by the spread of fertility control and exhibited higher marital fertility than couples without premarital births.

Context and data

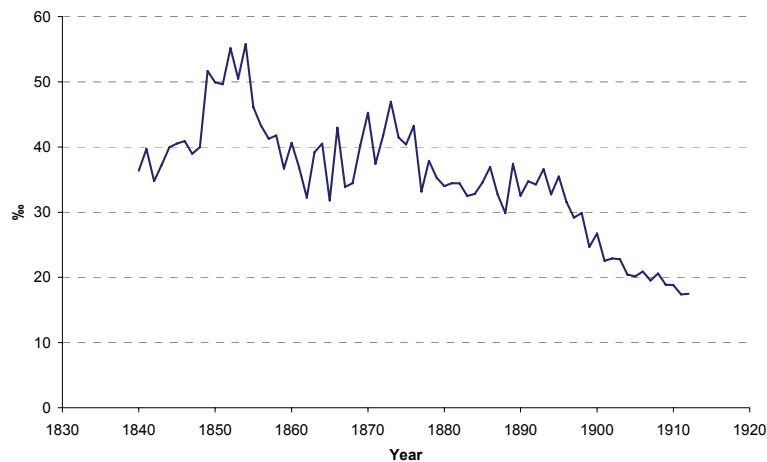
This contribution will test whether there is any effect of observed premarital conceptions and births on the subsequent marital fertility of three cohorts living in the town of Leuven. This town is situated in the Dutch-speaking part of Belgium, where economic modernization, secularisation and the fertility transition generally lagged behind the southern part of the country during the nineteenth century (Lesthaeghe 1977). Economically, Leuven has a very long urban tradition as an administrative, trades and crafts centre. In the middle of the nineteenth century, about a third of the registered labour force worked in indus-

try, while a fifth was employed in non-specific sectors. Intense but temporary immigration from the rural environment provided for day labourers, who came and went with the seasons. Overall, 45% worked in services, trades or transport. Only 3% was employed in agriculture (Magits 1975).

Leuven played a supportive role in the Belgian industrialization story, primarily through its functions as a centre of education, trades, and transport. The small-scale local industry expanded and modernized only gradually, and included mainly food industry (especially breweries), craft textile manufacturing, tanneries, wood, and construction (Matthijs, Van Bavel & Van de Velde 1997).

Employment opportunities for women in industry were very scarce. The single most important industrial occupation for women was lace making. The others women working in industry were seamstresses, dressmakers, knitters, laundresses and comparable, traditionally female working class occupations (Magits 1975). Not surprisingly, this white collar, bourgeois town recruited many domestic servants, mainly young women coming from the rural villages; 30% of the registered female labour force consisted of servants in 1846, making up the single most important occupational category for women. Clearly, this was an important factor in attracting female immigrants to Leuven. The town also hosted students and many soldiers, as well as male day labourers who were often finding unstable employment and housing in Leuven (Matthijs et al. 1997).

Fig. 2: Non-marital general fertility rate: number of births out of wedlock per 1000 unmarried women aged 15 to 45 years, Leuven 1840-1910

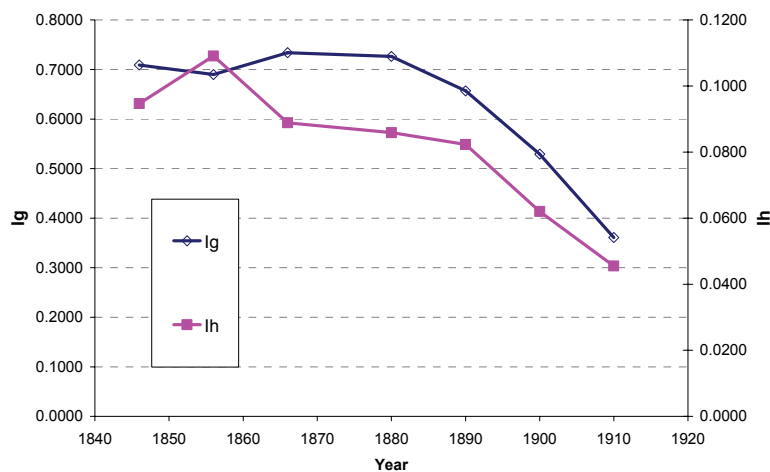


Source: own calculations based on censuses and official vital statistics

Typically, illegitimacy figures were relatively high in garrison- and university towns compared to their provinces (Mitterauer 1983: 72). This traditionally

held for Leuven as well. Like in many other European places (Shorter 1971), illegitimacy reached its highest peaks in the middle of nineteenth century. Between 1846 and 1856, one in five to more than one in four births was illegitimate. A more precise index is the illegitimacy rate, which is a non-marital general fertility rate: it is calculated as the number of illegitimate children born per 1000 unmarried women aged 15 to 45. Between 1845 and 1860, every year about 40 to more than 50 children were born per 1000 unmarried women of childbearing age (see Figure 2). During this period of economic crisis, the number of foundlings and abandoned children peaked as well. Between 1846 and 1856, the number of foundlings and abandoned children varied between 40 and 160 per year. In 1854, for instance, 1000 children were born, of which one in four out of wedlock, while nearly 160 children were abandoned or became foundlings. The figures for 1849 are similar (Van Bavel 2001).

Fig. 3: Coale-indices of marital fertility (Ig – left hand axis) and non-marital fertility (Ih – right hand axis), Leuven 1846-1910¹



Source: own calculations based on censuses and official vital statistics

The secular decline of illegitimate fertility started after 1880, which is about the same time when marital fertility started to decline (see Figure 3). As said, it is this parallelism in the decline of legitimate and illegitimate fertility which inspired the claim that the common cause is the diffusion of innovative contraceptive behaviour.

An assumption of that diffusionist interpretation of the decline of illegitimate fertility is that women who get pregnant before marriage are less aware of

¹ See Coale and Treadway (1986) for a formal definition of the indices.

effective contraceptive or abortive practices, or are applying them in a less effective way. The implication is that these women would also be less likely to apply contraceptive or abortive behaviour within marriage than comparable women without births or pregnancies before marriage. This hypothesis will now be investigated by looking at the marital fertility of three birth cohorts living in the Belgian town of Leuven between 1850 and 1910.

Tab. 1: Sample of marriages for three birth cohorts, Leuven (Belgium)

	1830 cohort	1850 cohort	1864 cohort
Number of marriages	493	659	630
with:			
- no premarital birth nor premarital pregnancy	42.39%	37.78%	45.40%
- premarital conception, marriage before childbirth	20.49%	23.53%	19.36%
- premarital birth(s)	37.12%	38.69%	35.24%
	100.00%	100.00%	100.00%

Note: all marriages are first marriages for the wife

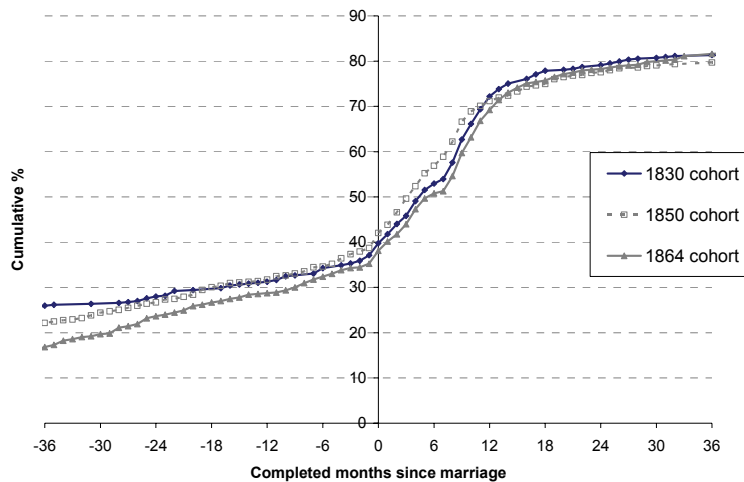
Source: Population registers and civil registration records (Van Bavel 2002)

Individual-level fertility data, for men as well as for women, natives as well as immigrants, were collected from the population registers and from civil registration (birth, death, and marriage certificates) for three birth cohorts (for a discussion of these sources, see Gutmann and van de Walle 1978; Lebouté and Obotela 1988; Alter 1988; Oris 1990). The first cohort consists of all married couples with at least one of the spouses born in 1830. This generation was included because it completed its fertile life course before any signs of marital fertility decline were visible on the aggregate level (G1830). The second cohort includes all married couples with at least one spouse born in 1850. This cohort entered its fertile life phase at a time when marital fertility was starting to decline in Leuven (G1850). The third generation, with at least one spouse born in 1864, was living its adult years in full marital fertility transition (G1864) (Van Bavel 2002). The following analyses are limited to women's first marriages because premarital pregnancies among women who never married before on the one hand, and premarital pregnancies among remarrying women on the other, are probably very different issues. Table 1 contains basic information about the sample of married couples.

Figure 4 gives the cumulative probability distribution function of the interval between marriage and the first birth attributed to it, irrespective of whether it was born before or after the wedding-day. That illegitimacy was quite high in Leuven is confirmed by the high proportions of women who brought premarital children to their first marriages. In the first generation this was 37%. In

the second, the percentage stood even somewhat higher at nearly 39%. The decline of premarital fertility was evidenced only in the third generation, with a percentage of 35% of first marrying women with premarital births (see also Table 1). In these figures, only premarital births are counted that were subsequently legitimised by marriage.²

Fig. 4: Cumulative probability distribution (per cent) of interval between marriage and first birth, by generation. Leuven 1846-1910



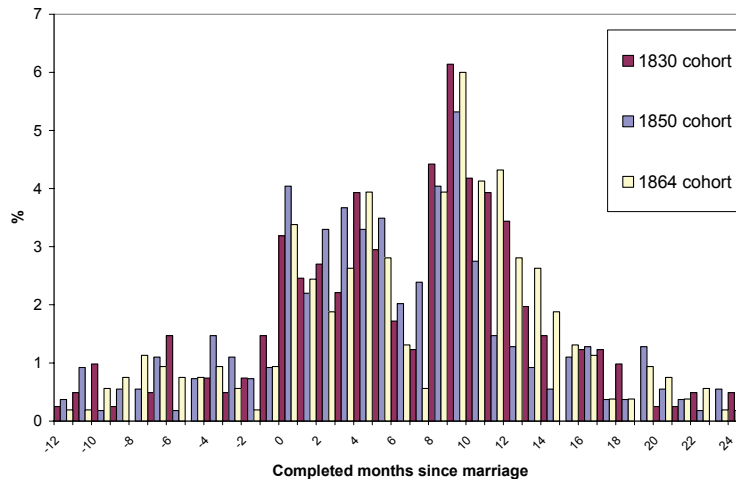
Source: same as Table 1

After one year of marriage, in each generation, about 70% had given birth to at least one child, born before or after marriage. About 80% had given birth within three years (Figure 4). Within the first 12 months of marriage, the frequency distribution of first births shows a markedly bimodal shape (Figure 5). This pattern is usually taken as an indicator of relatively permissive attitudes toward premarital sexual activity (Alter 1988: 131-132). More specifically, the closer the first peak in post-nuptial births is to the wedding-day, the more likely that the prevailing culture was tolerant toward pre-nuptial conceptions. If couples would want to hide prenuptial conceptions, they should want to marry as soon as the pregnancy would be noticed, if possible. In that case, birth would take place seven or eight months after marriage instead of after four or five

² These percentages are about 10% higher than the ones displayed for Leuven in Matthijs (2001: p.145). This can be explained by the fact that Matthijs includes not only first but also higher order marriages. Still, the timing of the onset of the decline of the proportion of marriages legitimising at least one child, as evident from Matthijs (2001: p.145), is consistent with the figures cited for the three generations used in the current study.

months. Those who were not ashamed of a prenuptial pregnancy could wait for several months to marry. Their childbirths would take place shortly after or even before marriage.

Fig. 5: Percent of first births by interval between marriage and first birth, by generation, Leuven 1846-1910



Source: same as Table 1

The next section presents a method to find out whether men and women who were able to avoid premarital pregnancies or births, were also more adept at controlling their fertility after marriage.

Method

As often in historical demography, the problem is to tell natural fertility differences from differences caused by deliberate fertility control. In his study of fourteen German villages in the eighteenth and nineteenth century, Knodel (1988: 226-239) noted that women who were pregnant at their wedding generally experienced modestly higher marital fertility rates than those who were not. A number of factors could account for this difference, including deliberate fertility control as well as differential fecundity. Knodel tends to favour the latter explanation when writing that if “sexual activity were routine following betrothal or a commitment to marry, a pregnancy prior to marriage would be more likely to ensue for couples who were more fecund than for those who

were less” (p.236). Indeed, he found in his eighteenth- and nineteenth-century German data that pregnant brides subsequently had higher marital fertility. Yet, Knodel failed to point out that the difference in marital fertility between women who had been pregnant brides and those who had not, (a) was more consistent and stronger in the nineteenth than in the eighteenth century, and (b) that pregnant brides had higher marital fertility especially above age 30, in particular in the nineteenth century. These findings can be deduced from Table 9.11 in Knodel (1988: 237). Assuming that fertility control by stopping behaviour became more prevalent in the course of the nineteenth century, this German evidence suggests that deliberate stopping was more frequently applied by women who had not been pregnant brides.

The next section fits multivariate regression models of marital fertility that include a number of controls for the natural and structural covariates of marital fertility, as well as a variable that should allow us to detect parity-aimed stopping behaviour. If the diffusionist interpretation of the decline of illegitimacy is correct, we should observe more evidence of such control among women without premarital pregnancies and births than among women who did become pregnant before marriage.

Modelling stopping behaviour

The approach taken is built on the tradition in historical demography to look at the age at last birth as an indicator of stopping behaviour. In case of natural fertility, the age at last birth is determined by the length of birth intervals and by the onset of sterility. People with long birth intervals tend to have a lower age at last birth (Okun 1995), but the most important natural determinant is the onset of sterility (Wilson, Oeppen & Pardoe 1988).

The fertility transition is characterised by the diffusion of a third determinant of the age at last childbirth, called parity-dependent stopping behaviour (Coale 1986). This mode of fertility control is aimed at a desired family size: parity-dependent stopping means that couples who have reached a maximum desired family size, try to prevent further reproduction (Okun 1995).

Instead of modelling the age at last birth directly, taking married women as the unit of analysis, we follow a sequential approach. A sequential approach is advisable because, if the age at last birth is partly determined by parity-dependent stopping, then this behaviour is by definition a function of the number of children alive, and this number is changing with time during the reproductive life course. So instead of modelling age at last birth in one step for individual women, we use birth intervals as unit of analysis. The dependent variable is the probability that the current birth interval remains open, i.e. the probability that no more birth occurs after the one that started the current interval. In other words, we model the probability that the age at last birth is the age

at the start of the current interval. This probability can be modelled by means of a logistic regression (Van Bavel 2004).

More precisely, the dependent variable is the logit-transformation of the probability that no more child is born within five years after a previous birth. There are two reasons for applying the five-year limit. First, waiting until women have reached the age of 45 or 50 years means limiting the analysis to completed unions, excluding all observed marriages that are censored by emigration or marriage dissolution. This reduces and probably distorts the sample. The reduction and distortion is smaller if we wait at most five years for a next birth. Second, demographers have argued and demonstrated that the number of children born more than five years after the previous one, is negligibly small (Larsen and Menken 1989), and this also holds for the current sample (Van Bavel 2002). Therefore, the following analysis assumes that couples who did not get another child within five years, had terminated childbearing. The model tries to predict the probability that this happened.

Covariates of birth stopping

From the above discussion, it is clear that a multivariate logit model of birth stopping should include indicators for sterility, birth spacing, and parity. Our main hypothesis is that we will observe a stronger effect of the latter variable among women who did not get pregnant before their first marriage.

If couples do not deliberately try to stop having children, the most important determinant of the onset of infertility is the woman's age (Trussell and Wilson 1985; Larsen and Menken 1989; Wood et al. 1994). In order to capture the non-linear effect of age on sterility, we include age at the start of the birth interval in the form of five-year age categories, indicated by dummy variables.

Secondly, in the absence as well as in the presence of parity-dependent fertility control, marriage duration is highly associated with fecundability and, hence, with birth spacing and therefore with the probability that another birth occurs within five years (Van Bavel 2003). After controlling for woman's age and marriage duration, the fecundity of marriages still varies significantly. Differences between couples reflect differential fecundability and breastfeeding habits (Knodel 1988; Wood 1994). Couples characterized by high fecundity will have, on average, shorter birth intervals and, hence, a higher cumulative number of births at any age and marriage duration. For these couples, the probability that the current interval is closed by yet another birth will also be relatively high. Therefore, the crude legitimate parity covariate, i.e. the number of children already born within the current marriage at the start of the current birth interval, is included to control for natural fecundity differences (Van Bavel 2004).

The survival status of the previous child has been shown to be a very important determinant of the next interval when the previously born infant is breast-

fed (Wood 1994). Infant mortality will therefore enhance the likelihood of an additional birth. This covariate is included in the regression equations as a dummy variable that is set to one if the previously born child dies within the current birth interval and before reaching age one.

Finally, if the reproductive behaviour would be deliberately aimed at a final family size that the married couple (or one of the partners) does not wish to exceed, we would expect a positive effect of the number of children alive on the odds of stopping. Hence, we are looking here at parity-dependent stopping from the perspective of reproduction, distinguishing net parity from crude parity: the former is the number of children still alive at the beginning of the current interval, while the latter includes all children already born, alive as well as deceased. If net parity has a statistically significant effect on the likelihood of stopping, even after controlling for crude parity (or, equivalently, the number of deceased children), this would strongly suggest that parity progression was being controlled with a desired offspring in mind. Van Bavel (2003; 2004) gives more details about the theoretical and methodological rationale behind including both crude and net parity. Table 2 gives basic descriptive statistics about all covariates mentioned. The next section discusses how they affect stopping behaviour.

Findings

Table 3 displays maximum likelihood estimates for the logistic regression analyses of birth stopping, modelled separately for three groups (columns) within three birth cohorts (see the sub-panels of the table). Within each birth cohort, we distinguish between the following three groups of married women: (1) those who did not record any pre-nuptial pregnancy; (2) women who did get pregnant before marriage, but who got married before the birth of the child; and (3) women who gave birth to at least one child before getting married. In each of these groups, the presence of parity-dependent stopping behaviour is assessed by looking at the effect of the number of children alive (also called net parity, in contrast to crude parity, i.e. the number of births).

The estimated effect parameters are presented in exponentiated form ($\exp(b)$) in order to allow interpretation in terms of odds ratios (see Pampel 2000 for an introduction to applied logistic regression analysis). For example, the effect of the wife being 40 years or older is estimated to be 6.508 in cohort 1830 for those without a pre-nuptial pregnancy, as compared to the reference category of women aged 20 tot 29 years. This means that the odds to stop childbearing rather than to have at least one more birth were more than six times as high for married women aged 40 years or over than for women aged 20 to 29 years, *ceteris paribus*. In the same group, the effect of marriage duration is estimated to be 1.298. This implies that the odds to stop childbearing

rather than to proceed to the next parity are estimated to increase with 29.8% per additional year that the marriage has already lasted. The p-values are for Wald Chi-square tests of statistical significance.

In general, higher age and marriage duration are both associated with higher odds of stopping in all generations and groups, as it should be (although sometimes the effects are statistically insignificant in smaller groups). In contrast, the higher the number of children already born in the past, the lower the likelihood that a couple will stop giving birth and, hence, the higher the likelihood that it will continue reproduction. As argued elsewhere, this reflects the fact that the number of children already born at a given age and marriage duration is a proxy for the combined influence of fecundability and postpartum amenorrhea (Van Bavel 2003; 2004; Van Bavel and Kok 2005). Again, in some smaller groups, this covariate has no statistically significant effect.

The death of the lastborn child during its infancy (below age one) tends to defer birth stopping: this covariate is estimated to be negatively associated with the odds of stopping in most groups, although mostly in a statistically insignificant way. We now turn to the variable that is at issue here and that is included in order to detect parity-dependent birth stopping: net parity.

In the first two generations, there was no statistically significant effect of the number of children alive on stopping in any group. In the 1830 cohort, if anything, the effect of net parity was negative rather than positive among people without any premarital pregnancy ($p < 0.084$). This would imply a higher likelihood of additional births among people who already have a large family, *ceteris paribus*. If this effect is real, several explanations are plausible. One possible reason is the heterogeneity of this group with respect to reproductive goals: maybe some natalistic part of the population was striving for large family sizes rather than trying to limit their offspring. Another explanation may be that it captures some of the non-linearity of the effect of crude parity. In the 1850 cohort, all statistically significant effects are what we would expect in the absence of deliberate, parity-dependent stopping. There is one interesting exception, however: among the women of generation 1850, the higher the number of children born *before* marriage, the higher the probability of stopping, all else equal. More precisely, each additional child born before marriage is estimated to be associated with a 75.8% increase in the odds of stopping. This seems to contradict the diffusionist hypothesis that illegitimacy is a sign of poor contraceptive knowledge. As an alternative explanation, premarital childbearing may for some couples be a reflection of a liberal attitude towards reproduction instead of a sign of contraceptive incompetence, especially if there was not just one illegitimate “accident” but several premarital births that may not have been undesired at all. If that is true, this liberal attitude may also be associated with earlier stopping in a “bastardy-prone subsociety” (Laslett 1980b). This may explain the positive effect of the number of premarital children on stopping behaviour – recall that *all* women within this group have given birth to at least

one child before first marrying. Yet, there is no effect of total family size (including children born before as well as during marriage) on stopping, after controlling for the number already born before marriage. Apparently, for couples with premarital children, it is not family size as such that seems to affect stopping but rather the number of children already born *before* marriage.

In the third generation, cohort 1864, we find a clear effect of achieved family size on stopping. However, we only find a statistically significant effect among women who did get pregnant before marriage but married before childbirth: per additional child alive, the odds of stopping increased with about 56%, after controlling for age, marriage duration, number of confinements, and survival status of the previous child. Among women without a premarital conception, the effect of family size is in the expected direction but statistically not significant. There is clearly no net effect of family size on stopping behaviour among couples who had at least one premarital birth. However, just like in the 1850 cohort, the stopping of parity progression within this group of couples seems to have been affected by the number of children born before marriage rather than by total family size. All else equal, an additional child born before marriage is associated with a 61.8% increase in the odds of stopping.

Tab. 2: Descriptive statistics for birth intervals used in analysis of stopping behaviour, Leuven (Belgium), 1850-1910:
means and standard deviations (s.d.)

	No premarital birth nor pregnancy		Premarital conception, marriage before childbirth		Premarital birth	
	Mean	s.d.	Mean	s.d.	Mean	s.d.
Cohort 1830						
Age of wife	33.22	5.52	32.59	5.78	35.65	4.88
Marriage duration (years)	7.60	4.25	8.41	5.42	7.83	4.68
Number of children born	4.25	2.07	4.61	2.31	5.72	2.23
Number of children still alive	3.23	1.66	3.63	1.87	4.29	1.75
Previous child died below age 1	0.21	0.41	0.15	0.36	0.18	0.38
Bride pregnant at wedding date					0.11	0.32
Number of premarital children					1.59	1.03
Number of birth intervals	384		286		221	
Cohort 1850						
Age of wife	32.10	5.41	31.64	6.09	33.10	5.37
Marriage duration (years)	7.64	4.66	8.65	5.83	8.74	5.24
Number of children born	4.35	2.23	4.68	2.40	6.40	2.73

Contin. Tab. 2:

Number of children still alive	3.48	1.81	3.78	4.93	2.13
Previous child died below age 1	0.14	0.36	0.13	0.16	0.36
Bride pregnant at wedding date				0.32	0.47
Number of premarital children				1.43	0.91
Number of birth intervals	392		427		528
Cohort 1864					
Age of wife	31.97	5.31	31.54	32.35	5.62
Marriage duration (years)	7.62	4.87	8.19	8.20	4.87
Number of children born	3.93	1.97	4.61	5.76	2.25
Number of children still alive	3.29	1.70	3.52	4.71	1.66
Previous child died below age 1	0.10	0.30	0.15	0.15	0.35
Bride pregnant at wedding date				0.44	0.50
Number of premarital children				1.46	0.77
Number of birth intervals	302		235		416

Source: same as Table 1

Tab. 3. Logistic regression of probability of birth stopping in three birth cohorts, Leuven (Belgium), 1850-1910

	No premarital birth nor pregnancy			Premarital conception, marriage before childbirth			Premarital birth		
	exp(b)	s.e.(b)	p	exp(b)	s.e.(b)	p	exp(b)	s.e.(b)	p
Cohort 1830									
Intercept	0.113	0.384	<.001	0.126	0.494	<.001	0.058	0.786	<.001
Age of wife									
- 20-29 (ref)	1.000	/	/	1.000	/	/	1.000	/	/
- 30-34	0.745	0.455	0.519	1.475	0.531	0.464	0.208	0.962	0.103
- 35-39	2.195	0.428	0.067	3.146	0.608	0.059	1.196	0.781	0.819
- 40 and +	6.508	0.497	<.001	46.709	0.783	<.0001	5.296	0.928	0.072
Marriage duration (years)	1.298	0.069	<.001	1.045	0.093	0.636	1.081	0.112	0.487
Number of children born	0.825	0.143	0.180	1.001	0.228	0.998	0.851	0.236	0.494
Number of children still alive	0.788	0.138	0.084	0.797	0.187	0.225	1.386	0.206	0.113
Previous child died below age 1	0.408	0.406	0.027	0.749	0.536	0.589	0.359	0.648	0.115
Bride pregnant at wedding date							2.935	0.613	0.079
Number of premarital children							0.936	0.328	0.841
Number of birth intervals	384			286			221		
Deviance (-2loglikelihood)	315.479			209.387			158.955		

Contin. Tab. 3:

Cohort 1850									
Intercept	0.086	0.412	<.001	0.157	0.339	<.0001	0.060	0.478	<.0001
Age of wife									
- 20-29 (ref)	1.000	/	/	1.000	/	/	1.000	/	/
- 30-34	1.946	0.447	0.136	1.257	0.384	0.552	1.403	0.462	0.464
- 35-39	3.465	0.479	0.010	2.961	0.419	0.010	3.153	0.494	0.020
- 40 and +	23.717	0.644	<.001	10.204	0.540	<.0001	16.315	0.590	<.0001
Marriage duration (years)	1.360	0.061	<.001	1.126	0.059	0.043	1.275	0.059	<.0001
Number of children born	0.632	0.145	0.002	0.832	0.152	0.226	0.663	0.112	<.0001
Number of children still alive	0.887	0.152	0.431	0.931	0.145	0.624	0.944	0.097	0.551
Previous child died below age 1	1.460	0.411	0.357	0.632	0.405	0.258	1.164	0.375	0.685
Bride pregnant at wedding date							1.043	0.337	0.900
Number of premarital children							1.758	0.181	0.002
Number of birth intervals	392			427			528		
Deviance (-2loglikelihood)	288.294			378.572			360.763		

Contin. Tab. 3:

Cohort 1864									
Intercept	0.371	0.314	0.002	0.242	0.416	<.001	0.113	0.482	<.001
Age of wife									
- 20-29 (ref)	1.000	/	/	1.000	/	/	1.000	/	/
- 30-34	1.675	0.324	0.111	1.018	0.442	0.968	1.230	0.379	0.586
- 35-39	2.376	0.436	0.047	1.487	0.533	0.456	2.009	0.468	0.136
- 40 and +	5.775	0.598	0.003	29.605	0.868	<.001	5.526	0.566	0.003
Marriage duration (years)	1.113	0.053	0.044	1.228	0.073	0.005	1.296	0.074	<.001
Number of children born	0.645	0.190	0.021	0.484	0.187	<.001	0.691	0.146	0.011
Number of children still alive	1.235	0.197	0.283	1.561	0.200	0.026	0.947	0.152	0.720
Previous child died below age 1	0.883	0.438	0.777	1.371	0.469	0.501	0.504	0.440	0.119
Bride pregnant at wedding date							1.020	0.298	0.948
Number of premarital children							1.618	0.266	0.071
Number of birth intervals	302			235			416		
Deviance (-2loglikelihood)	358.830			222.304			369.009		

Source: same as Table 1

Conclusion and discussion

One of the major arguments made in the literature in support of the view that the nineteenth century fertility transition was the result of the spread of an innovation called contraception, is that illegitimate fertility fell together with marital fertility. Indeed, the parallel decline of both illegitimacy and marital fertility in the final part of the nineteenth century suggests that individuals in Europe were applying new forms of contraceptive behaviour that were previously not done or even unthinkable. This paper has investigated one implication of the argument: if the diffusion hypothesis is correct, one would expect that women with premarital births would be less likely to apply parity-dependent stopping behaviour within marriage than comparable women without premarital births. This hypothesis has been investigated using data from three birth cohorts living in the Belgian town of Leuven between 1850 and 1910.

The results presented in this paper do not contradict the diffusionist interpretation of the decline of illegitimacy, but there is also no unequivocal and straightforward support for it. At the same time, the findings highlight the importance of an alternative view on premarital conceptions and births. This alternative view has been called “the courtship model”.

The diffusionist interpretation holds that “the spread of the knowledge and skills to avoid unwanted births enabled both married and unmarried couples to reduce their fertility simultaneously” (Knodel & van de Walle 1986: 403). The courtship model maintains that illegitimacy declined as a result of improved marriage opportunities for courting couples. There is no contradiction between both views: both can be true at the same time. Some findings presented above can be explained by the diffusion model, other findings can better be understood within the courtship model.

To start with the key issue of this paper: we found that in Leuven, married couples with at least one premarital birth were not applying parity-dependent stopping as a function of their total family size. We did find evidence of stopping behaviour aimed at family size limitation for couples without premarital births. This supports the diffusionist interpretation so far as it goes. However, this evidence could only be found among couples who, indeed, did not have any children before marriage but who did *conceive* their first child before marriage. The latter qualification can better be explained by the courtship view of premarital sexual intercourse, as explained below.

Before discussing how these results support both the diffusion hypothesis and at the same time the courtship view, let’s try to answer the following question first. Why is there no evidence that people without any premarital conceptions were able to limit their family size? Indeed, this finding seems to be sur-

prising from the point of view of the diffusion hypothesis. One possible explanation is that this is the most heterogeneous group: it includes people who did *not* have sex before marriage as well as people who *did* but who were effectively applying contraception (like coitus interruptus) or abortion, as well as couples with lower fecundity (see groups (a), (b), (c), and (f) in Figure 1, respectively). Group (a), characterised by premarital chastity, may include a disproportional number of strong adherents to the prescriptions of the clergy. The Catholic church did not approve of sex before marriage while at the same time favouring pro-natal attitudes (Stengers 1971; Phayer 1977). Couples adhering to the teachings of the Church stand in sharp contrast to group (b), who apply contraception to intervene in God's will, and even more in contrast to group (c), who even turn to abortion in order to avoid unwanted births. Yet, all these groups are lumped together into the same category in the above analysis because our historical data do not allow us to distinguish between them.

Couples with a premarital conception but without a premarital birth, clearly did have coitus before marriage without applying effective contraception or abortion. The finding that this group in particular, once married, was the one that was most clearly applying parity-aimed fertility control, indicates that premarital pregnancies were probably not unwanted. Apparently, premarital pregnancy was not the result of deviant behaviour but rather an expected result of normal courtship in the local popular culture of Leuven. This confirms earlier findings (Van Bavel 2001) and supports the courtship model. Contraception and abortion was only applied in order to avoid *unwanted* births. This paper suggests that children conceived before marriage but born after the wedding date were not considered unwanted.

The birth of children out of wedlock probably *was* an unwanted event for most couples. Premarital births may often have been the result of premarital sex without effective contraception or abortion in the absence of realistic marriage opportunities. Therefore, assuming that unwed motherhood was not a desirable status, the diffusionist interpretation considers illegitimacy to be a sign of poor practical knowledge of contraception. Yet, even though there was no significant net effect of total family size on the stopping of childbearing in our sample, there *was* a positive association between the number of kids born before marriage and the likelihood of stopping. This seems to contradict the diffusion hypothesis. As an alternative explanation, premarital childbearing may reflect liberal attitudes towards reproduction for some couples instead of signalling contraceptive incompetence. Especially if there was not just one illegitimate "accident" but several premarital births, illegitimacy may not have been undesired at all. If that is true, this liberal attitude may also be associated with earlier stopping. This may explain the positive effect of the number of premarital children on stopping behaviour.

To conclude, the decline of illegitimacy during the second half of the nineteenth century can at most only partly be explained by the diffusion of innova-

tive contraceptive behaviour. At least, that is the conclusion that may be drawn from the situation in the Belgian town of Leuven. More than backing up the diffusionist interpretation, the findings presented here lend particular support to the courtship model of premarital pregnancies and births. And, finally, non-marital childbearing may also have reflected, during the starting episode of the fertility transition, a liberal attitude towards reproduction, much like in the "second demographic transition" (Lesthaeghe and Neels 2002). This liberal attitude may, in turn, also be positively associated with early stopping behaviour.

References

- Alter, G. 1988. *Family and the Female Life Course: The Women of Verviers, Belgium, 1849-1880*. Madison (Wisc.): University of Wisconsin Press.
- Cleland, J. 2001. "Potatoes and Pills: an Overview of Innovation-Diffusion Contributions to Explanations of Fertility Decline." Pp. 39-65 in *Diffusion Processes and Fertility Transition: Selected Perspectives*, ed. J. B. Casterline. Washington, D.C.: National Academy Press.
- Coale, A. J. 1986. "The Decline of Fertility in Europe Since the Eighteenth Century As a Chapter in Demographic History." Pp. 1-30 in *The Decline of Fertility in Europe*, eds. A. J. Coale and S. C. Watkins. Princeton (N.J.): Princeton University Press.
- Coale, A. J. and R. Treadway. 1986. "A Summary of the Changing Distribution of Overall Fertility, Marital Fertility, and the Proportion Married in the Provinces of Europe." Pp. 31-181 in *The Decline of Fertility in Europe*, eds. A. J. Coale and S. C. Watkins. Princeton (N.J.): Princeton University Press.
- Cutright, Ph. 1971. "Illegitimacy: myths, causes and cures." *Family Planning Perspectives* 3(1): 25-48.
- Gutmann, M. P. and E. van de Walle. 1978. "New Sources for Social and Demographic History: The Belgian Population Registers." *Social Science History* 2(2):121-43.
- Knodel, J. 1988. *Demographic Behavior in the Past: A Study of Fourteen German Village Populations in the Eighteenth and Nineteenth Centuries*. Cambridge: Cambridge University Press.
- Knodel, J. and E. van de Walle. 1986. "Lessons From the Past: Policy Implications of Historical Fertility Studies." Pp. 390-419 in *The Decline of Fertility in Europe*, eds. A. J. Coale and S. C. Watkins. Princeton (N.J.): Princeton University Press.
- Kok, J. 1990. "The moral nation. Illegitimacy and bridal pregnancy in the Netherlands from 1600 to the present." *Economic and Social History in the Netherlands* 2: 7-35.
- Kok, J. 1991. *Langs verboden wegen. De achtergronden van buitenechtelijke geboorten in Nood-Holland 1812-1914*. Hilversum: Verloren. (Hollandse Studiën 27)
- Larsen, U. and J. Menken. 1989. "Measuring sterility from incomplete birth histories." *Demography* 26(2): 185-201.

- Laslett, P. 1980a. "Introduction: Comparing Illegitimacy Over Time and Between Cultures." Pp. 1-65 in *Bastardy and Its Comparative History*, eds. P. Laslett, K. Oosterveen, and R. M. Smith. London: Edward Arnold.
- Laslett, P. 1980b. "The Bastardy Prone Sub-Society." Pp. 217-46 in *Bastardy and Its Comparative History: Studies in the History of Illegitimacy and Marital Nonconformism in Britain, France, Germany, Sweden, North America, Jamaica and Japan*, P. Laslett, K. Oosterveen, and R. M. Smith. London : Arnold.
- Laslett, P., K. Oosterveen, and R. M. Smith, eds. 1980. *Bastardy and Its Comparative History: Studies in the History of Illegitimacy and Marital Nonconformism in Britain, France, Germany, Sweden, North America, Jamaica and Japan*. London: Edward Arnold.
- Leboutte, R. and R. Obotela. 1988. "Les registres de population en Belgique. Genèse d'une technique administrative et d'une source de démographie historique." *Handelingen van de Koninklijke Commissie voor Geschiedenis / Bulletin de la Commission Royale D'Histoire* (3-4): 285-305.
- Lesthaeghe, R. 1977. *The Decline of Belgian Fertility, 1800-1970*. Princeton (N.J.): Princeton University Press.
- Lesthaeghe, R. and K. Neels. 2002. "From the first to the second demographic transition: an interpretation of the spatial continuity of demographic innovation in France, Belgium and Switzerland." *European Journal of Population* 18(4): 325-360.
- Magits, M. 1975. *Demografische en sociale structuren te Leuven (1846-1860). Bijdrage tot de stadsgeschiedenis in de 19de eeuw*. Brussel: VUB, Centrum Sociale Structuren en Economische Conjunctuur.
- Matthijs, K. 2001. *De mateloze negentiende eeuw. Bevolking, huwelijk, gezin en sociale verandering*. Leuven: Universitaire Pers Leuven.
- Matthijs, K., J. Van Bavel, and I. Van de Velde. 1997. *Leuven in de negentiende eeuw. De bevolking: een spiegel van het dagelijkse leven*. Leuven: ACCO. (Leuvense Archiefbronnen: Nieuwe visies 1)
- McQuillan, K. 1999. *Culture, Religion, and Demographic Behavior: Catholics and Lutherans in Alsace, 1750-1870*. Montreal, Canada: McGill-Queen's University Press.
- Mitterauer, M. 1983. *Ledige Mütter. Zur Geschichte Unehelicher Geburten in Europa*. München: Verlag C.H. Beck .
- Okun, B. S. 1995. "Distinguishing Stopping Behavior from Spacing Behavior with Indirect Methods." *Historical Methods* 28(2): 85-96.
- Oris, M. 1988. "Fécondité légitime et illégitime: les indigents de Huy (Belgique) de 1815 à 1875." *Annales de Démographie Historique* 1988: 141-155.
- Oris, M. 1990. "Le couplage des registres de population belges, XIXe-XXe siècles." *Revue Informatique et Statistique dans les Sciences Humaines* 26: 145-181.
- Pampel, F. C. 2000. *Logistic Regression. A Primer*. Thousand Oaks: Sage. (Quantitative Applications in the Social Sciences 132)
- Phayer, J. M. 1977. *Sexual Liberation and Religion in Nineteenth Century Europe*. London: Croom Helm.
- Schellekens, J. 1995. "Illegitimate Fertility Decline in England, 1851-1911." *Journal of Family History* 20(4): 365-377.
- Segalen, M. 1993. *Sociologie De La Famille*. Paris: Armand Colin.

- Shorter, E. 1971. "Illegitimacy, Sexual Revolution, and Social Change in Modern Europe." *Journal of Interdisciplinary History* 2: 237-272.
- Shorter, E., J. Knodel, and E. van de Walle. 1971. "The Decline of Non-Marital Fertility in Europe, 1880-1940." *Population Studies* 25(3): 375-393.
- Stengers, J. 1971. "Les pratiques anticonceptionnelles dans le mariage au XIXe et au XXe siècle: problèmes humains et attitudes religieuses." *Revue Belge De Philologie Et D'Histoire* 49(4): 403-481.
- Szreter, S. 1996. *Fertility, Class and Gender in Britain, 1860-1940*. 1 ed. Cambridge: Cambridge University Press. (Cambridge Studies in Population, Economy and Society in Past Time 27)
- Tilly, L. A., J. W. Scott, and M. Cohen. 1976. "Women's Work and European Fertility Patterns." *Journal of Interdisciplinary History* 6(3):447-76.
- Trussell, J. and C. Wilson. 1985. "Sterility in a population with natural fertility." *Population Studies* 39(2): 269-286.
- Van Bavel, J. 2001. "Family control, bridal pregnancy, and illegitimacy. An event history analysis in Leuven, Belgium, 1846-1856." *Social Science History* 25(3): 449-479.
- Van Bavel, J. 2002. *Van natuurlijke naar gecontroleerde vruchtbaarheid? Geboortebeperving in Leuven, 1846-1910*. Leuven: Universitaire Pers Leuven. (Sociologie Vandaag 6)
- Van Bavel, J. 2003. "Does an effect of marriage duration on pre-transition fertility signal parity-dependent control? An empirical test in 19th century Leuven, Belgium." *Population Studies* 57(1): 55-62.
- Van Bavel, J. 2004. "Diffusion effects in the European fertility transition: historical evidence from within a Belgian town (1846-1910)." *European Journal of Population* 20(1): 63-85.
- Van Bavel, Jan and Jan Kok. 2005. "Are deliberate birth spacing effects in fact statistical and bio-demographic artefacts? A critical study with data from the Netherlands." Paper presented at the XXVth IUSSP International Population Conference, 18-23 July 2005, Tours, France.
- Watkins, S. C. 1986. "Regional Patterns of Nuptiality in Western Europe, 1870-1960." Pp. 314-36 in *The Decline of Fertility in Europe*, eds. A. J. Coale and S. C. Watkins. Princeton: Princeton University Press.
- Wilson, C., J. Oeppen, and M. Pardoe. 1988. "What is natural fertility? The modelling of a concept." *Population Index* 54(1): 4-20.
- Wood, J. W. 1994. *Dynamics of Human Reproduction. Biology, Biometry, Demography*. New York: Aldine De Gruyter.
- Wood, J. W., D. J. Holman, A. I. Yashin, R. J. Peterson, M. Weinstein, and M.-C. Chang. 1994. "A multistate model of fecundability and sterility." *Demography* 31(3): 403-426.